## APPENDIX B

# TIC Architecture and User Interface Evaluation Test Plan

# *ADVANCE*

**Advanced Driver and Vehicle**
**Advisory Navigation Concept**

## TIC Architecture & User Interface Evaluation Test Plan Document # 8464.ADV.00

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# TIC ARCHITECTURE AND USER INTERFACE EVALUATION TEST PLAN

## TABLE OF CONTENTS

# 1. EXECUTIVE SUMMARY

## 1.1 Purpose and scope

The *ADVANCE* Transportation Information Center (TIC) was developed as an operational test to assess the potential for improving the existing traffic operations in the Chicago area. This was achieved by integrating the *ADVANCE* operational test with IDOT District One operations, which involved providing for the transfer of information from the Traffic System Center (TSC), the Closed Loop Signal System (CLSS), the Communication Center (including *999), the ISHTA automated toll collection system, and Northwest Central Dispatch to the *ADVANCE* TIC. In addition, a further goal of the project partners in creating the *ADVANCE* TIC was to provide a basis for an enhanced transportation system of the future. This enhancement incorporates both the application of the existing *ADVANCE* TIC concept to other locations and the broadening of the concept within the Chicago area to include additional transportation information and management services. This goal is now of particular relevance with the development of the Gary-Chicago-Milwaukee Corridor concept.

The *ADVANCE* TIC evaluation has the overall goal of assessing the degree to which the implemented TIC Architecture and operational practices meet the needs of all the agencies involved or affected by the system operation, both at the present time and into the future. The *ADVANCE* TIC configuration could act as a model for implementations in other traffic systems. The evaluation will result in a detailed description of the advantages and shortcomings of the TIC Architecture and User Interface as presently configured. To achieve this, various aspects of the performance of the various TIC subsystems, both individually and as a complete system, are to be assessed. In addition, human factors issues relating to TIC operation are also to be assessed as part of the evaluation.

This document, the TIC Architecture and User Interface Evaluation Test Plan (ETP), contains a detailed description of the evaluation goals, objectives and Measures of Effectiveness (MOEs), the system elements to be evaluated, the specific data collection and analysis tasks to be performed during the evaluation, and the responsibilities of each of the parties involved in the evaluation.

The evaluation goals of the TIC Architecture and User Interface evaluation as defined by the project parties are listed below. Within each of these evaluation goals, various detailed objectives and MOEs are to be addressed, details of these are provided in subsequent sections of this document.

*Goal A: Evaluate the performance of the TIC Architecture.*

Specific objectives within this goal include the assessment of the TIC Architecture itself, that is, how the various components perform together, in addition to the individual assessment of the

performance of the two main elements covered by this evaluation: the TIC hardware, and the TIC software. The identification of potential system design alternatives which could result in greater efficiency of operations will also take-place within this goal.

*Goal B: Evaluate the expandability and transferability of the ADVANCE TIC.*

Specific objectives within this goal include an investigation into the potential for extending the functionality of the *ADVANCE* TIC to provide additional transportation information and management capabilities in the current test area, and an assessment of the applicability of the current *ADVANCE* TIC implementation to other geographical areas.

*Goal C: Evaluate the cost efficiency of the TIC.*

Within this goal, the costs associated with all aspects of TIC installation and operation will be documented, and potential areas for cost savings will be examined.

*Goal D: Evaluate operational practices at the TIC.*

Within this goal, the operational practices in place at the TIC will be investigated in order to identify any areas where current practices impact the efficient operation of the TIC. Within this goal the staffing requirements of the TIC will also be examined.

*Goal E: Evaluate the human factors aspects of TIC operation.*

Objectives to be assessed within this goal include the aspects of the TIC Interface usability and functionality which affect efficient TIC operation and operator comfort.

## 1.2 Management and Responsibility

De Leuw, Cather & Company (DCCO) staff are responsible for the overall management of the TIC evaluation. This includes the evaluation planning effort represented by this document, the performing of all data collection and analysis activities, the monitoring of evaluation progress to ensure that task scheduling remains on target and that Quality Assurance procedures are adhered to, and the preparation of all interim and final reports. Human factors expertise will also be provided as part of the DCCO team, to perform evaluation data collection and analysis of the objectives relating to TIC User Interface human factors issues.

*ADVANCE* Project Office staff, primarily the TIC operators, will be involved in some of the tasks of data collection at the TIC, and forwarding this data to the DCCO evaluation team as specified in subsequent sections of this document. Data collection activities will include the completion of the TIC real-time log, the TIC operator observation log, and the retrieval of automated logs provided by the TIC systems as required. TIC operators will also be interviewed as part of the human factors evaluation tasks.

The Illinois Universities Transportation Research Consortium (IUTRC), though not directly involved in the data collection and analysis activities of the TIC evaluation, will provide any necessary technical advice regarding ongoing operation of the TIC systems if required during the evaluation operation. They will also provide assistance in retrieving electronic logs from the TIC. In addition, IUTRC staff involved in the development of TIC systems are to be interviewed as part of the architecture performance evaluation objectives.

Argonne National Laboratory (ANL) is the evaluation manager for the *ADVANCE* project as a whole, and as such is responsible for approving all status reports, interim reports and the final report, of the TIC Architecture and User Interface subtest. (This function is referred to throughout this Evaluation Test Plan as the *ADVANCE* Evaluation Manager.) Though ANL is not actively involved in the actual data collection and analysis activities of the TIC subtest evaluation, it is responsible for storing all archived data resulting from the evaluation.

The Illinois Department of Transportation (IDOT) is the contracting agency with DCCO. Prior to submitting the interim and final reports to ANL, IDOT approval will be requested. Weekly status reports will be submitted simultaneously to IDOT and ANL.

## 2. DETAILED PLAN

As outlined in the Executive Summary above, the *ADVANCE* TIC evaluation has the overall goal of assessing the degree to which the implemented TIC Architecture and operational practices meet the needs of all the agencies involved or affected by the system operation, both at the present time and into the future. The evaluation will result in a detailed description of the strengths and shortcomings of the architecture and user interface as presently configured.

This section of the Evaluation Test Plan (ETP) contains a detailed description of the evaluation goals,. objectives and Measures of Effectiveness (MOEs), the system elements to be evaluated, the specific data collection and analysis tasks to be performed during the evaluation, scheduling information, and the responsibilities of each of the parties involved.

As the evaluation breaks down into two clearly delineated areas, the evaluation of the TIC Architecture and the evaluation of the TIC User Interface, this detailed plan section of the ETP document is subdivided accordingly. The following subsections, Section 2.1 and Section 2.2, contain details of the evaluation scheme and test scheme, for the TIC Architecture and for the TIC User Interface respectively.

### 2.1 TIC Architecture

The evaluation of the system architecture comprises various measures which, in combination, will provide an indication of how the various system components perform together, in addition to the

individual assessment of the performance of the main subsystems: the TIC hardware and TIC software.

The identification of potential system design alternatives which could result in greater efficiency of operations will also take place. In addition, the expandability and transferability of the *ADVANCE* TIC concept will be assessed, as will TIC cost efficiency. The operational practices and staffing requirements of the TIC will also be investigated.

### 2.1.1 TIC Architecture goals and objectives

The evaluation goals and objectives relating to the TIC Architecture are listed below. Within each of the principal goals a series of more detailed objectives is specified. The objectives seek to define each goal in more detail in terms of the individual issues or system elements which are to be examined within the evaluation process.

**Goal A:** **Evaluate the performance of the TIC Architecture**
**Objectives:**
- A.1 Evaluate the performance of the TIC hardware
- A.2 Evaluate the performance of the TIC software
- A.3 Evaluate potential system design alternatives

**Goal B:** **Evaluate the expandability and transferability of the** *ADVANCE TIC*
**Objectives:**
- B.1 Evaluate TIC Architecture expandability
- B.2 Evaluate TIC Architecture transferability

**Goal C:** **Evaluate the cost efficiency of the TIC**
**Objectives:**
- C.1 Evaluate TIC system costs
- C.2 Evaluate alternative TIC cost options

**Goal D:** **Evaluate operational practices at the TIC**
**Objectives:**
- D.1 Evaluate TIC policies and procedures
- D.2 Evaluate TIC staffing requirements

### 2.1.2 TIC Architecture Measures of Effectiveness (MOEs)

For each of the above objectives relating to the evaluation of the TIC Architecture, **specific** Measures of Effectiveness (MOEs) have been selected. Following the listing of the MOEs below, a test plan for the MOEs is provided. This test plan provides detailed information on the types of data, the methods of collection and analysis, and all other issues which must be specified in order to meet the evaluation objectives. The MOEs for the TIC Architecture evaluation objectives are listed below.

**Objective A.1** **Evaluate the performance of the TIC hardware**
**MOEs**
A. 1.1 TIC hardware functionality
A. 1.2 TIC hardware reliability
A. 1.3 TIC hardware maintenance requirements
A. 1.4 TIC hardware efficiency

**Objective A.2** **Evaluate the performance of the TIC software**
**MOEs**
A.2.1 TIC software functionality
A.2.2 TIC software reliability
A.2.3 TIC software maintenance requirements
A.2.4 TIC software efficiency

**Objective A.3** **Evaluate potential system design alternatives**
**MOE**
A.3.1 Number and type of elements of the architecture which could be simplified to reduce system complexity without compromising system performance

**Objective B.l** **Evaluate TIC Architecture expandability**
**M O E**
B. 1.1 Number and type of additional transportation information and management functions which could be consolidated within the *ADVANCE* TIC

**Objective B.2** **Evaluate TIC Architecture transferability**
**MOE**
B.2.1 Number and type of elements and capabilities of the *ADVANCE* TIC **which** are non-specific to the Chicago area implementation and which could be utilized to provide TIC services in other geographic locations

**Objective C.l** **Evaluate TIC system costs**
**MOEs**
C. 1.1 Fixed and variable TIC capital costs
C. 1.2 Fixed and variable TIC operating costs

**Objective C.2** **Evaluate alternative TIC cost options**
**MOEs**
C.2.1 Number and type of elements of the TIC implementation which could be simplified to reduce cost without compromising system performance
C.2.2 Alternative cost options

**Objective D. 1** **Evaluate TIC policies and procedures**
**MOEs**
D. 1.1 Number and type of areas where policy and procedure impact efficient TIC operation or operator workload
D. 1.2 Number and type of revisions to TIC policies and procedures recommended to streamline TIC operations or operator workload

| | |
|---|---|
| **Objective D.2** | **Evaluate TIC staffing requirements.** |
| **MOEs** | D.2.1 Number and type of difficulties resulting from existing staffing levels experienced during TIC operation which effect TIC efficiency or operator workload |
| | D.2.2 Number and type of revisions to TIC staffing levels recommended to streamline TIC operations or operator workload |

### 2.1.3 Test plan for TIC Architecture MOEs

The following sub-section contains the test plan for the above MOEs relating to TIC Architecture. As many elements of the evaluation schemes and test schemes for these MOEs are similar or identical, a combined MOE test plan is provided. Where scheduling information is provided, this is described in terms of weeks from commencement of evaluation period, in order that the plan does not require updating should the evaluation start date be subject to change.

2.1.3.1 Evaluation scheme

2.1.3.1.1 Evaluation overview

The purpose of this test is to evaluate the performance of various elements of the TIC architecture, including the TIC hardware and software, and to document how these elements perform as a whole system. Several characteristics have been selected for the hardware and software evaluation: functionality, that is, what functions the elements perform; and reliability and maintenance requirements, that is, how frequently systems are unavailable, the cause of any system failures, and what interventions are necessary to return systems to full operation. In addition, the efficiency of the hardware and software systems will be documented by recording various system throughput times. In addition, using the results of the review of the system functionality as input, potential system design alternatives will be described in terms of the number and type of elements of the TIC Architecture which could be simplified to reduce system complexity without compromising system performance.

The TIC Architecture expandability will be reviewed by identifying any other functions the *ADVANCE* TIC could incorporate to streamline additional traffic information or management functions in the Chicago area. In addition, the transferability of the TIC concept to other geographic locations will be assessed by identifying elements of the TIC which are not specific to the current implementation and matching these against the requirements of other areas for this type of service. The TIC capital and operating costs will be documented and possible alternative cost options which could reduce any of these system costs will be identified.

The final aspects of the TIC Architecture to be evaluated concern TIC operating policies, procedures and staffing requirements. Any issues which have an impact on the effectiveness of TIC operation or staff workload will be identified. If recommendations for revising any procedures or staffing levels are made, the impacts of introducing these will also be documented.

2.1.3.1.2 Hypotheses to be tested

**Hypothesis 1:** The TIC Architecture as implemented for the *ADVANCE* targeted deployment operational test provides an acceptable level of performance, both in terms of the hardware and software as individual components, and as a complete system.

**Hypothesis 2:** The TIC Architecture as implemented for the *ADVANCE* targeted deployment operational test is expandable to cover additional services within the current test area.

**Hypothesis 3:** The TIC Architecture as implemented for the *ADVANCE* targeted deployment operational test **is** transferable to other geographic areas.

**Hypothesis 4:** The TIC Architecture as implemented for the *ADVANCE* targeted deployment operational test provides acceptable cost efficiency.

**Hypothesis 5**: The operational practices in place at the *ADVANCE* TIC enable acceptable system operation and ensure reasonable operator workload.

2.1.3.1.3 Evaluation approach

*Experimental design*

The TIC Architecture evaluation comprises four main parts as reflected partly by the above hypotheses. The type of data requiring collection and analysis varies between each of these parts, thus influencing the experimental design.

For data relating to Hypothesis 1, techniques of both automated and manual logging of various measures of system performance are to be undertaken in conjunction with review of system specification documentation. Measures obtained will be compared to the desired levels of performance as detailed in the system requirements documentation. **As the** *ADVANCE* TIC provides a service which was non-existent in the area prior to **its** implementation and it forms a unique system, it has not been possible to design the evaluation test around either a before-after or test-control basis.

For Hypotheses 2 and 3, again a process of documentation review will be undertaken in combination with a review of possible additional services which could be incorporated in the *ADVANCE* TIC, and review of the requirements for similar services in other areas.

Data relating to Hypothesis 4 will consist of a summary of all the costs involved in the design, procurement, implementation and acceptance testing of the TIC systems, in addition to the everyday operating costs, to include maintenance costs, TIC operator, supervisor and support technician salaries, and all other costs incurred. The assessment of the cost efficiency of the TIC Architecture will be enabled by means of comparison with system alternatives identified as part of

the same task.

For Hypothesis 5, the data will be collected by means of surveys, interviews and observations carried out by the evaluation team. For any areas where difficulties are identified which are caused by existing operational practices, recommendations to revise these will be made in the interim and final reports. Again, the experimental techniques of before-after or test-control design are not applicable here.

*Data collection methodology*

As summarized above, the data collection methodology for each of the four main areas of the TIC Architecture evaluation varies. The following paragraphs describe in further detail the data collection processes for each of these areas.

For MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality, the data collection will consist of the collation of relevant system specification and requirements documentation as listed in the *ADVANCE* Project Management Plan. If further details on functionality are required or if clarification of any information contained in the system documentation is necessary, free-form interviews with system designers and operators will be undertaken. Due to the nature of the data to be collected in this manner, no structured log sheets or questionnaires will be utilized.

For MOEs A. 1.2 TIC hardware reliability, A. 1.3 TIC hardware maintenance requirements, A.2.2 TIC software reliability, and A.2.3 TIC software maintenance requirements, data will be collected by means of the TIC real-time log. This log will record the time and date when a malfunction occurred, if known, and when it was identified, system experiencing failure, known or suspected cause of failure, maintenance action necessary, the time system became operational again, and the identity of the operator completing the log should any further clarification of the log be required after the event. The TIC real-time log is contained in Appendix A.

For MOEs A. 1.4 TIC hardware efficiency and A.2.4 TIC software efficiency, measures of time to process several forms of data will be recorded. There are no appropriate automated logs provided by the TIC Architecture to record the progress of data throughout the entire system. Therefore several separate automated logs created by the system which describe separate processes require accessing and the data fields of interest require copying into a single file.

Data that will be collected for MOEs A. 1.4 and A.2.4 is as follows. The time to process data originating from Northwest Central Dispatch arrives in the form of an automated log at the TIC. The operator'is required to manually scan this log and filter out data that relate to residential streets not covered by the *ADVANCE* project and data that will not affect traffic. This data is then manually transferred from the NWCD log into the TIC system. This last process is also performed for data from other sources including ISHTA, *999 and any other anecdotal sources. Data to be recorded for the efficiency evaluation are: time data entered in NWCD log, time data

received at TIC, and the time that the operator completes manual data entry process at TIC and data is forwarded to the relevant TRF processes. From this time, the data takes a maximum of 5 minutes within the TRF cycle. After this the data passes through the message scheduler as it cycles through the queue. The combination of these times will provide an indication of the total time taken to process data involvingoperator intervention at the TIC.

The logging of the time that data is sent from source, the times as it is processed by the various algorithms within the TIC, and the time when data is output from the TRF process will also take place for data from the Traffic System Center (TSC), the Closed Loop Signal System (CLSS, with masters based at locations on Dundee Road), and probe reports received from the equipped vehicles. During the pre-test activities, the DCCO team with staff from IUTRC will devise and test the methods for extracting data from the various log files and the database, and for compiling this into a format which facilitates analysis of total time to process data.

Tests will also be performed to ascertain the maximum amount of data that can be entered into the system before the 5 minute cycle stalls, as data is cycled through chronologically, and data beyond the 5 minute cut-off point is not processed. This test will determine if the 5 minute cycle is adequate for the amount of data that requires processing during the targeted deployment. In addition, measurements will also be made of the duration of the back-up cycle necessary in order that the efficiency of TIC functions is not compromised.

Data will be collected relating to the efficiency of the TIC in remaining operational without human intervention. This will be calculated by calculating the amount of data entered manually as a proportion of the total data used by the TIC, most of which enters the system and is processed automatically.

For MOE A.3.1, Number and type of elements of the architecture which could be simplified to reduce system complexity without compromising system performance, the input data will feed from the earlier data collection undertaken for MOEs A. 1.1 to A.2.4 relating to hardware and software performance. The overviews of the various aspects of system performance previously collected will be used as the basis for a consultation process with an peer review team comprising IUTRC technical staff.

For MOEs B. 1.1 and B.2.1, concerning TIC Architecture expandability and transferability, part of the input data will be taken from the earlier data collection undertaken for MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality. Peers familiar with the transportation situation in the Chicago area will participate in a review process to consider the additional services which could be incorporated into the TIC operation using the functionality review documentation.

MOEs C. 1.1 through C.2.2 relating to TIC Architecture capital and operating costs will be assessed using all the available expenditure information provided by *ADVANCE* project partners. Data will be collated from project partners and *ADVANCE* Project Office financial records to

provide as full a picture as possible of the financial investment in the TIC Architecture subsystem of the overall *ADVANCE* project. As data is collected, it will be entered into a spreadsheet software package to aid analysis.

Data for MOEs D. 1.1 to D.2.2 relating to the impact of policies, procedures and staffmg levels on efficient TIC operation will be collected both by means of a structured questionnaire and by informal discussion sessions with TIC operators and supervisors. The questionnaire will be administered towards the end of the evaluation period in order to enable maximum exposure of the operators to the procedures in place at the TIC. In addition, a non-real-time TIC operator observation log will be available at all times during the TIC Architecture evaluation period to enable operators or the supervisor to note any issues which are relevant to operational practices and other issues. TIC operators and the supervisor will be briefed at the outset of the evaluation period on the purpose and scope of the operational practices evaluation, informed of the purpose of the TIC operator observation log, and notified that they will be interviewed near the end of the evaluation period. The TIC operator observation log is provided in Appendix A.

*Data reduction methodology*

Not all of the data to be collected during the TIC Architecture evaluation will require data reduction processes. This includes for example, the descriptive qualitative data collected on the system functionality, expandability and transferability of the TIC' Architecture, and the TIC operational practices. Similarly, the system design alternatives evaluation comprises a qualitative analysis on the results of the hardware and software functionality evaluation and as such will require no formal data reduction procedures.

The quantitative data relating to system reliability and maintenance requirements taken from the TIC real-time log will be manually entered into a data analysis software package which will then be used to calculate the Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR) for the TIC hardware and software. The data collected relating to hardware and software efficiency, which will consist of measures of time for various types of data to be processed by the TIC Architecture, will also be reduced into a format suitable for analysis using this method. Though this data will have been compiled from several separate TIC logs into one file it is anticipated that this data will then require manual entry into the analysis software package. Graphical representations of the data enabled by the spreadsheet software will facilitate this analysis. Data relating to hardware and software efficiency MOEs will be collected during the pre-test period while DCCO team staff and IUTRC staff are finalizing the methods of tracking the data through the TIC processes. If the data collected are suitable and if the logging methods are refined sufficiently early, it is intended to utilize the data collected during this period for analysis and inclusion in the Final Report in order to allow the maximum length of time for data collection.

*Data analysis methodology*

The data analysis methodology for each of the four main areas of the TIC Architecture evaluation again varies by type of data. The following paragraphs describe in further detail the data analysis processes for each of these areas.

For the MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality, the results of the documentation review and system designer interviews will undergo a comparative assessment against the desired hardware and software functionality as described in system requirements documentation.

For the MOEs A. 1.2 TIC hardware reliability, A. 1.3 TIC hardware maintenance requirements, A.2.2 TIC software reliability, and A.2.3 TIC software maintenance requirements, data will have been entered manually onto the TIC real-time log. The quantitative measures of the time and date when a malfunction occurred, if known, and when it was first identified, and the time and date the system became operational again will have been entered into the analysis software package in order to calculate the Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR). This data will be sorted by the particular process or hardware element experiencing failure where possible in order to identify weaknesses in the system. In addition, the process or hardware experiencing failure, the known or suspected causes of failure, and the maintenance actions necessary will be categorized by type where possible. This data will then be manually analyzed and presented in textual format.

For MOEs A. 1.4 TIC hardware efficiency and A.2.4 TIC software efficiency, measures of time to process several forms of data will have been recorded and entered into the analysis software package. These measures will be separated by type of data and mean times to process the various types will be calculated. The results of this analysis will undergo further processing to discover under what conditions, such as peak periods, the TIC Architecture efficiency is influenced, if at all.

For MOE A.3.1, Number and type of elements of the architecture which could be simplified to reduce system complexity without compromising system performance, the data from the earlier data collection for MOEs A. 1.1 to A.2.4 relating to hardware and software performance will be subject to a qualitative peer review analysis process. The product of this process will be a textual description of any elements which have been identified as being capable of streamlined.

For MOE B. 1.1, concerning TIC Architecture expandability, part of the input data will be taken from the earlier data collection undertaken for MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality. Peers familiar with transportation situation in the Chicago area will participate in a review and analysis process to consider the additional services which could be incorporated into the TIC operation using the functionality review documentation. Following this, the peer review team will examine the technical, organizational, and financial impacts of expanding the TIC Architecture to incorporate these additional functions. The result of this

process will be a textual description of any additional transportation information or management systems whose incorporation in a single hub would enhance their technical or organizational operation or would reduce operating costs.

For MOE B.2.1, concerning TIC Architecture transferability, again part of the input data will be taken from the earlier data collection undertaken for MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality. A peer review team will undertake a review process in which the number and type of elements and capabilities of the *ADVANCE* TIC which are non-specific to the Chicago area implementation and which could be utilized to provide TIC services in other geographic locations will be identified. Following this process, the requirements of other areas for *ADVANCE* TIC capabilities will be outlined. The result of this process will be an assessment of the extent to which an *ADVANCE-type* TIC could be implemented to meet local requirements in other areas.

MOEs C. 1.1 and C. 1.2 comprise the detailed TIC system cost information gathered during the previous data collection stage which will have been entered to a spreadsheet software package to facilitate analysis. This data will form the input to MOEs C.2.1 and C.2.2 which are concerned with alternative TIC Architecture cost options. The data analysis tasks relating to costs will comprise a comparative assessment of the actual system components and their respective costs with potential alternative components whose implementation could reduce costs without compromising system performance. The result of this quantitative analysis will be a series of recommendations for streamlining system costs if this is found to be necessary.

Data for MOEs D. 1.1 to D.2.2 relating to the impact of policies, procedures and staffing levels on efficient TIC operation will have been collected both by means of structured questionnaires and by informal discussion sessions with to TIC operators and supervisors. The data resulting from the structured questionnaires will be in the form of a frequency distribution of responses. This data will be collated along with the input received from the informal discussions and the TIC operator observation log to provide the overall qualitative, subjective measure of operator response to the impact of operational practices both on efficient system operation and on their own workload.

*Key assumptions*

The key assumptions which will have to be made during the evaluation phase are outlined in the following paragraphs. For MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality, it is assumed that sufficient documentation exists to enable comprehensive review, and that access to this documentation is not problematic. In addition, the availability of system designers and operators for interviews if required is also assumed.

For MOEs A. 1.2 TIC hardware reliability, A. 1.3 TIC hardware maintenance requirements, A.2.2 TIC software reliability, and A.2.3 TIC software maintenance requirements, it is assumed that the information required in the TIC real-time log is available to the operators and that TIC

operators are correctly filling in the log sheet as instructed.

For MOEs A. 1.4 TIC hardware efficiency and A.2.4 TIC software efficiency, it is assumed that the various measures of time to process data are being accurately recorded by the system processes. In addition, it is assumed that the transcription of data from the various system logs to a single file, and the transfer of this file to the data analysis package is accurately performed. It is also assumed that the TIC is operating to a sufficient level of performance prior to the data collection activities.

For MOE A.3.1, Number and type of elements of the architecture which could be simplified to reduce system complexity without compromising system performance, it is assumed that the input data from previous functionality analyses is accurate. It is assumed that the peer review team has sufficient knowledge of both the implemented TIC system and possible alternatives to be able to undertake the review process, and that the team members are not positively or negatively biased towards the existing TIC Architecture.

For MOEs B. 1.1 and B.2.1, concerning TIC Architecture expandability and transferability, again it is assumed that the input data from previous functionality analyses is accurate. It is assumed that the peer review team has sufficient knowledge of the transportation situation in the Chicago area and of national ITS requirements, and that the team members are not positively or negatively biased towards the existing implementation. It is assumed the peer review participants will consist of members of the existing DCCO team.

For MOEs C. 1.1 to C.2.2 relating to TIC Architecture capital and operating costs it must be assumed that data relating to these items are available, that costs are itemized in sufficient detail and that data are accurate. It must also be assumed that cost data are correctly entered into the analysis package.

For MOEs D. 1.1 to D .2.2 relating to the impact of policies, procedures and staffing levels on efficient TIC operation it must be assumed that the TIC operators and the supervisor are available to take part in the questionnaires and informal discussion process and that they are not positively or negatively biased towards the existing TIC operational practices. In addition, it must be assumed that the TIC operator observation log is being completed by operators whenever appropriate.

*Key constraints*

The key constraints, or limitations, of the evaluation process which must be taken into consideration are outlined in the following paragraphs. For all MOEs relating to the TIC Architecture evaluation, the key limitation will be the availability and completeness of data from all sources, whether these be manual or automated logs, subjective data obtained from questionnaires or during discussions, or the knowledge of the various peers involved in the consultation process.

It must also be recognized that the *ADVANCE* project is a targeted deployment with a limited number of vehicles in the field. As such the amount of probe data processed by the system will represent a small proportion of that which would be processed in a large-scale test or during full operation. However, data input from all other sources will be comparable to a larger implementation.

2.1.3.1.4 Key evaluation events

The key evaluation events are itemized in this section. Further detail on the scheduling and interdependencies of the various evaluation activities is provided in the Section 2.1.3.2, the Test Scheme, and Section 3, the Test Management Plan. Evaluation events are described in terms of weeks from commencement of the evaluation period, in order that the plan does not require updating should the evaluation start date be subject to change.

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|---|---|
| **Week** 1 | Pre-test activities |
| **Week 5** | Commencement of all data collection and analysis activities |
| | Perform daily data validation checks |
| | Submit first weekly progress report to *ADVANCE* Evaluation Manager |
| **Week 6** | Start weekly data validation checks |
| **Week 11** | Prepare interim evaluation report for Weeks 5-10 |
| **Week 16** | Conclude evaluation data collection activities) |
| **Week 24** | Complete final evaluation reports |

2.1.3.1.5 References


- *ADVANCE* Evaluation Program Plan. Document #8400.ADV.03. July 17, 1995.
- *ADVANCE* Project Management Plan. Document #8200.ADV.Rev. 13. March 31, 1995.


**7.1.3.2 Test scheme**

2.1.3.2.1 Physical description

*Test scenario*

The test scenario for the TIC Architecture evaluation activities is the *ADVANCE* Project Office, mainly within the TIC itself during targeted deployment system operation. The data collection activities form two main types: first, the completion or compilation of manual and automated logs within the TIC; and second, the questionnaires, informal discussion sessions, and peer reviews.

*Work Breakdown Structure for participants*

De Leuw, Cather & Company (DCCO)

- Perform overall evaluation management
- Perform data collection and analysis activities
- Monitor evaluation progress to ensure that task scheduling remains on target
- Ensure Quality Assurance procedures are adhered to
- Prepare all interim and final reports

*ADVANCE* Project Office *(ADVANCE* PO)

- Complete TIC real-time log
- Assist in retrieving automated logs provided by the TIC systems
- Assist DCCO staff with other data collection tasks where necessary
- Forward data to the DCCO evaluation team
- Participate in interviews and discussion sessions

Illinois Universities Transportation Research Consortium (IUTRC)

- Assist in retrieving automated logs provided by the TIC systems
- Provide any necessary technical advice regarding ongoing operation of the TIC systems if required during the evaluation operation
- Participate in interviews

Argonne National Laboratory (ANL)

- Store all archived data resulting from the evaluation tests

2.1.3.2.2 Pre-test activities

*Participant roles and responsibilities*

Table 1 contains the list of tasks to be completed prior to the initiation of the full data collection and analysis effort, with the individual participant responsibilities identified.

| ACTIVITY | RESPONSIBILITY |
|---|---|
| Perform overall evaluation management | DCCO manager |
| Ensure all parties involved in the evaluation tasks are fully briefed regarding their individual responsibilities | DCCO team |
| Devise method for automated log collation into form suitable for analysis | DCCO team / IUTRC |
| Train TIC operators and supervisor in completion of TIC real-time log and TIC operator observation log, and collation of electronic logs | DCCO team |
| Ensure all data collection sheets have been finalized and that adequate supplies are available | DCCO team |
| Verify that TIC Architecture is fully operational and that no further modifications will be required throughout data collection period | DCCO team |
| Contact participants to finalize dates for review panels | DCCO team |
| Monitor evaluation pre-test progress to ensure that scheduling remains on target | DCCO manager |
| Inform all participants of start of data collection phase | DCCO manager |

**Table 1 Pre-test activities and responsibilities**

*Resource requirements*

Effort required to complete the pre-test activities is summarized in Section 3, the Test Management Plan. Access to the other participants for briefing purposes, and for training in the use of the various logs will also be required.

*Location*

*ADVANCE* Project Office

*Dry runs and training*

Dry runs of TIC real-time log and the TIC operator observation log completion and electronic data log compilation will be undertaken during the TIC operator training session. The DCCO manager will also ensure that the evaluation team staff involved in data collection are fully informed of the procedures for data collection and analysis.

*Data management procedures*

The results from the completion of the logs during the training session will be analyzed to ensure that data is being comprehensively collected and entered on the logs, and that the types of data collected are sufficient to enable the objectives of the evaluation to be met. Any recommended

revisions to the data collection tools will be approved by the *ADVANCE* Evaluation Manager and IDOT prior to implementation, and will be documented fully in the weekly progress report, and appended to the TIC Architecture tesfplan.

2.1.3.2.3 Test conduct activities .

*Participant roles and responsibilities*

Table 2 contains the list of tasks to be completed during the data collection and analysis effort, with the individual participant responsibilities identified.

| ACTIVITY | RESPONSIBILITY |
|---|---|
| Continue overall evaluation management | DCCO manager |
| Perform data collection and analysis activities | DCCO team |
| Monitor completion of TIC real-time log and TIC operator observation log and collation of electronic logs by TIC operators | DCCO team |
| Monitor evaluation progress to ensure that task scheduling remains on target | DCCO manager |
| Ensure Quality Assurance procedures are adhered to | DCCO manager |
| Participate in interviews and peer reviews | DCCO manager and team / IUTRC |
| Prepare alI weekly progress and interim reports | DCCO team |
| Complete data collection using TIC real-time log and TIC operator observation log | *ADVANCE* PO |
| Retrieve automated logs provided by the TIC systems | DCCO team / *ADVANCE* PO / IUTRC |
| Assist DCCO staff with other data collection tasks where necessary | *ADVANCE* PO |
| Forward data to the DCCO evaluation team | *ADVANCE* PO |
| Participate in interviews and discussion sessions | *ADVANCE* PO |
| Provide any necessary technical advice regarding ongoing operation of the TIC systems if required during the evaluation operation | IUTRC |
| Archive all data resulting from the evaluation tests | ANL |

**Table 2 Test activities and responsibilities**

*Procedures*

The procedures to be followed throughout the data collection and analysis period are described in the following paragraphs.

The *ADVANCE* system specification and requirements documentation as listed in the *ADVANCE* Project Management Plan will be gathered at the outset of this period for detailed review. Clarification on any aspects of the system documentation required will be sought from system designers. A summary of these documents and input from designers will be prepared by the evaluation team and submitted to the *ADVANCE* Evaluation Manager for review. After any necessary revisions have been incorporated, this data will be used, first, to represent MOEs A. 1.1 TIC hardware functionality and A.2.1 TIC software functionality, and second, as input into subsequent tasks outlined below.

During the pre-test phase, the TIC operators will have been instructed in the use of the various log sheets they are required to complete or compile, and data collection and analysis dry-runs using these tools will have been performed. The TIC real-time log relating to MOEs A. 1.2 TIC hardware reliability, A. 1.3 TIC hardware maintenance requirements, A.2.2 TIC software reliability, and A.2.3 TIC software maintenance requirements will be completed on each occasion that a system malfunction is perceived by TIC operators. The composite logs compiled from the relevant system processes for MOEs A. 1.4 TIC hardware efficiency and A.2.4 TIC software efficiency will be prepared daily during the first week and weekly for the remainder of this phase. At the end of each day during the first week of live data collection, and weekly thereafter, these logs will be reviewed to ensure that data is being logged on a consistent basis and that it is complete.

Data collected previously relating to system functionality will be utilized as the basis for the consultation process with the peer teams for MOE A.3.1, Number and type of elements of the architecture which could be simplified to reduce system complexity without compromising system performance, and MOEs B. 1.1 and B.2.1, concerning TIC Architecture expandability and transferability. It should be noted that the separate meetings are envisioned to address each of these three issues. The data previously prepared will be forwarded to peer team members for their review not less than one week before they are scheduled to meet. It is anticipated that each of the peer review sessions will require one half day. Minutes from the review sessions and annotated copies of the input data containing the peer feedback will be used as the basis for separate, brief reports on potential system design alternatives, TIC Architecture expandability and TIC Architecture transferability. These documents will be circulated to peer reviewers for their approval, and any subsequent modifications will be incorporated and the documents re-distributed until approved.

For the MOEs C. 1.1 through C.2.2 relating to TIC Architecture capital and operating costs, available expenditure data will be collected from all available sources and entered into a software package for analysis. The output from this process will be circulated to affected participants not

less than two weeks before feedback is required from them on the accuracy and completeness of the data collected. Following this process, a discussion session will be scheduled to consider areas where potential cost savings relating to the TIC Architecture could be made. A brief report summarizing the results of these activities will be prepared and circulated among affected participants for review. Any subsequent modifications requested will be incorporated and the document re-distributed until approved by project participants.

Data for MOEs D. 1.1 to D.2.2 relating to the impact of policies, procedures and staffing levels on efficient TIC operation will be collected both by means of structured questionnaires and by informal discussion sessions with TIC operators and supervisors. The questionnaires will be administered in Week 12 of the data collection and analysis phase when live operation of the TIC has taken place for approximately two months. The results from the analysis of the TIC evaluation questionnaire and the TIC operator observation log will be used as the basis for an informal discussion session which will take place in Week 16 of the test. This will allow operators to elaborate on any of the issues raised in the questionnaire process, and add any others with the benefit of approximately three months experience of full TIC test operation.

*Location*

*ADVANCE* Project Office

*Data requirements*

The following data will be required during the TIC Architecture evaluation data collection and analysis phase.

- *ADVANCE* system specification and requirements documentation
- Further details on TIC Architecture functionality if clarification on system documentation is required
- Input on design alternatives
- Input on operational practices and any other observations made during system operation
- For reliability and maintenance requirements measurements, time and date of malfunction (if available), time and date when malfunction first identified, system experiencing failure, known or suspected cause of failure, maintenance action necessary, time system became operational again, and the identity of operator completing log sheet
- For hardware and software efficiency, measures of time to process dam
- Input from peer reviewers on number and type of elements of the architecture which could be simplified to reduce system complexity without compromising system performance, using data from the earlier data collection undertaken for hardware and software performance
- Input from peer reviewers on expandability of TIC Architecture based on results of TIC Architecture performance measures

- Input from peer reviewers on transferability of TIC Architecture based on results of TIC Architecture performance measures
- All available expenditure information relating to TIC Architecture capital and operating costs
- Input on operational practices and staffing levels

*Resources*

Effort required to complete the test activities is summarized in Section 3, the Test Management Plan. In terms of the hardware and software required to assist in the data collection and analysis activities, this either comprises tools already in place within the TIC Architecture for logging of processes or it consists of the analysis and word-processing packages already available within the *ADVANCE* Project Office. Continuous access to the analysis and word-processing packages will be required during this stage of the evaluation.

*Data management procedures*

The results from the completion of the logs during the data collection phase will be analyzed to ensure that data is being comprehensively collected and entered on the logs, and that the types of data collected are sufficient to enable the objectives of the evaluation to be met. These activities will be reported on in the interim reports. Any recommended revisions to the Evaluation Test Plan will be approved by the *ADVANCE* Evaluation Manager and IDOT prior to implementation, and will be documented fully in the weekly progress report, and appended to the TIC Architecture test plan.

*Procedures for periodic status reports to ADVANCE Evaluation Manager*

The DCCO evaluation team staff will prepare brief weekly status reports and submit these to the DCCO manager for review. These will then also be forwarded to the *ADVANCE* Evaluation Manager and IDOT for approval. An interim report will be prepared during the evaluation phase. It will summarize progress and data collected during Weeks 5-10. Data collected during Weeks 11-16 will feed directly into the final report together with the data already covered in the interim report.

2.1.3.2.4 Post-test activities

*Participant roles and responsibilities*

Table 3 contains the list of tasks to be performed following the data collection and analysis effort, with the individual participant responsibilities identified.

| ACTIVITY | RESPONSIBILITY |
|---|---|
| Continue overall evaluation management | DCCO manager |
| Collect all logs and complete data analysis | DCCO team |
| Verify all required data has been collected | DCCO team |
| Ensure Quality Assurance procedures are adhered to | DCCO manager |
| Monitor analysis and reporting progress to ensure that task scheduling remains on target | DCCO manager |
| Prepare final reports | DCCO team |
| Store all archived data resulting from the evaluation tests | ANL |

**Table 3 Post-test activities and responsibilities**

*Resource requirements*

Effort required to complete the test activities is summarized in Section 3, the Test Management Plan. In terms of equipment resources required, full-time access to one PC, and half-time access to a second PC, on both of which the analysis software package and word-processing facilities are installed will be required from Weeks 16 to 24 of the evaluation period. Access to printing and photocopying facilities will also be required. Equipment required will be supplied by DCCO.

*Reporting procedures*

*Report format and layout*

The interim and final reports will have the same basic structure to aid cross-checking of interim results with fmal results. Sections will be omitted from the interim reports for which data has not been collected at the time of their preparation. All documentation arising from the TIC Architecture evaluation will be prepared using WordPerfect 6.0a or higher. The proposed content and structure for the final evaluation report is given in Table 4 below.

| | |
|---|---|
| 1 | Executive summary<br>This section will contain sufficient detail to enable it to be published separately |
| 2 | Project overview<br>• Description of project innovations, the national lTS program, the *ADVANCE* project objectives addressed, and the specific goals and objectives of the operational test<br>• Brief overview of project over its duration, and highlights of project-related external factors and other significant events which have influenced the project<br>• Review of implementation process, including discussion of problems and issues encountered, steps taken to resolve such issues and problems, and associated operational delays, difficulties and other consequences, if any |
| 3 | Test site overview<br>• Description of the site, and any site-related external factors that may have influenced the project |
| 4 | Evaluation overview<br>• Description of the basic evaluation procedures and the timing of evaluation stages |
| 5 | Project results<br>• Assessment of the project in terms of its attainment of the relevant goals and objectives<br>• Presentation and analysis of relevant data in the form of charts, graphs, and narrative<br>• Findings and lessons learned, based on practical experience, relative to the implementation and operation of the system, including suggestions for project modifications at the test site or for future applications in other locations<br>• Assessment of evaluation procedures employed, including effectiveness of particular survey approaches used, accuracy of data collection techniques, also a description of analytical techniques employed |
| 6 | Appendix<br>• Data collection tools used, and samples of typical completed logs and questionnaire |

**Table 4 Final report structure**

*Expected data format and volume*

The quantitative data recorded using logs and then transferred to the analysis software package will have been reduced into various tabular structures to aid the analysis process. The findings from the analysis of this data will be summarized in textual format in the Interim and Final Evaluation Reports. The data tables themselves will be reproduced as Appendices of the Final Evaluation Report. The qualitative data collected by means of documentation review, questionnaires, interviews, discussions, and review panels will be presented in a descriptive, textual format.

The volume of data arising from the TIC Architecture evaluation cannot be accurately estimated at the time of writing of this Evaluation Test Plan, but will be estimated following the preparation of the first Interim Report at the end of Week 8 of the evaluation phase.

*Reporting schedule*

The reporting schedule for the evaluation phase is as follows:

| | |
|---|---|
| **Week 5** | Submit first of the weekly progress reports to *ADVANCE* Evaluation Manager |
| **Week 11** | Prepare interim evaluation report for Weeks 5-10 |
| **(Week 16** | Conclude data collection activities) |
| **Week 22** | Submit Draft Evaluation Report to *ADVANCE* Evaluation Manager for review |
| **Week 24** | Complete Final Evaluation Report incorporating feedback |

*Data processing and archival procedures*

All data relating to the TIC logs will have been archived and a copies of the **archive** data will have been stored by ANL throughout the evaluation period. One camera ready copy and one electronic copy of the Final Evaluation Report will be provided to the *ADVANCE* Evaluation Manager for dissemination.

## 2.2 TIC User Interface

The evaluation of the TIC User Interface comprises various measures which, in combination, will provide an indication of the TIC User Interface usability and functionality which affect efficient TIC operation and operator comfort and workload.

### 2.2.1 TIC User Interface goals and objectives

The evaluation goals and objectives relating to the user interface are listed below. Within each of the principal goals a series of more detailed objectives is specified. The objectives seek to define each goal in more detail in terms of the individual issues or system elements which are to be examined within the evaluation process.

**Goal E: Evaluate the human factors aspects of the TIC User Interface**
**Objectives:** E.1 Evaluate TIC Interface usability
E.2 Evaluate TIC Interface functionality

### 2.2.2 TIC User Interface Measures of Effectiveness (MOEs)

For each of the above objectives relating to the evaluation of the TIC User Interface, specific Measures of Effectiveness (MOEs) have been selected. Following the listing of the MOEs below, a test plan for the MOEs is provided. This test plan provides information on the types of data, the methods of collection and analysis, and all other issues which must be specified in order to meet the evaluation objectives. The MOEs for the TIC User Interface evaluation objectives are as follows.

**Objective E.1** **Evaluate TIC User Interface usability**

**MOEs**

E. 1.1 User perceptions of level of ease with which system can be operated in everyday use

E. 1.2 Number and type of difficulties reported by operators in everyday use

**Objective E.2** **Evaluate TIC User Interface functionality**

**MOEs**

E.2.1 Difference between desired and actual functionality of the TIC User Interface

E.2.2 Number and type of interface functions not utilized during TIC operation

### 2.2.3 Test plan for TIC User Interface MOEs

The following sub-section contains the test plan for the above MOEs relating to the TIC User Interface. As the evaluation schemes and test schemes for these MOEs are very similar, a combined MOE test plan is provided. Where scheduling information is provided, this is described in terms of weeks from commencement of evaluation period, in order that the plan does not require updating should the evaluation start date be subject to change.

#### 2.2.3.1 Evaluation scheme

2.2.3.1.1 Evaluation overview

The purpose of this test is to evaluate the usability and functionality of the TIC User Interface.

The usability of the interface relates to the ease with which the features of the interface can be utilized. The usability evaluation will consider elements of the system such as workstation layout, screen format, task and menu structure, the demands made by the system on the operator for data input or process monitoring, and the degree of feedback provided by the system to the operator. Any recommendations for revising any of the TIC User Interface features will also be documented.

The functionality of the interface refers to the features which are available to the operator to fulfill the tasks required. The functionality evaluation will assess these features to identify. any additional features that are required by the operator, any features which remain unused, and any features whose design negatively impacts TIC efficiency or which cause a disproportionate workload for the operator.

2.2.3.1.2 Hypotheses to be tested

**Hypothesis 6** : The TIC User Interface as implemented for the *ADVANCE* targeted deployment operational test provides and acceptable level of usability.

**Hypothesis 7:** The TIC User Interface as implemented for the *ADVANCE* targeted deployment operational test provides and acceptable level of functionality.

### 2.2.3.1.3 Evaluation approach

*Experimental design*

The TIC User Interface evaluation for both Hypothesis 6 and Hypothesis 7 will take the form of the TIC evaluation questionnaire administered to operators and the TIC supervisor, the completion of the TIC operator observation log, and sessions spent in the TIC observing operators utilizing the interface.

*Data collection methodology*

The following paragraphs describe in further detail the data collection processes for the TIC User Interface evaluation.

For MOE E. 1.1, User perceptions of level of ease with which system can be operated in everyday use, data be will collected by means of the TIC evaluation questionnaire. Data relating to MOEs E. 1.2, Number and type of difficulties reported by operators in everyday use, and E.2.1, Difference between desired and actual functionality of the TIC User Interface, will be collected using both the TIC evaluation questionnaire and the TIC operator observation log completed by the operators and supervisor. For MOE E.2.2, Number and type of interface functions not utilized during TIC operation, data collection will take place using the TIC evaluation questionnaire, the TIC operator observation log, and the TIC evaluator observation sheet.

The various types of data will be collected using a single TIC evaluation questionnaire and a single TIC operator observation log for all the above MOEs. The questionnaire provides a combination of closed and open questions in order to allow operators to expand on feedback given in response to the closed questions. This questionnaire will be provided in Week 8. In addition, a separate free-structured TIC evaluator observation sheet will be used by the human factors evaluation observer. This sheet will be provided in Week 6. The TIC operator observation log is provided in Appendix A of this Evaluation Test Plan.

*Data reduction methodology*

The data to be collected within the TIC User Interface Evaluation will take two forms. The first of these is the quantitative data relating to counts of feature usage, and problems encountered. This data will be entered from the logs and specialist observation data collection sheets into the data analysis software package.

The second data type will take the form of qualitative responses to various aspects of the TIC

User Interface. The responses to the closed survey questions will also be entered into the analysis software package. The free-text format responses to the open survey questions will be manually compiled.

*Data analysis methodology*

The data analysis methodology for the TIC User Interface again varies by type of data. The data for MOE E. 1.1, User perceptions of level of ease with which system can be operated in everyday use, gathered using closed survey questions, will be in the form of a frequency distribution of responses, and the ranking of usefulness of specific features and their usability. This data and the quantitative data for MOE E. 1.2, relating to counts of feature usage and problems encountered, and MOE E.2.2, Number and type of interface functions not utilized during TIC operation, will be analyzed within the analysis software package. This data will be categorized by the particular process or function of the interface where possible in order to identify weaknesses in the system. All other data will be analyzed manually to provide qualitative assessments of functionality and usability.

For MOE E.2.1, Difference between desired and actual functionality of the TIC User Interface, desired functionality measures will be taken from operator feedback on any additional features required. Actual functionality will be taken from both operator feedback and from system documentation if clarification is required. The product of this process will be a textual description of any elements which have been identified as being unnecessary, or additional features which are recommended for inclusion in the interface design.

*Key assumptions*

For all the MOEs relating to the TIC User Interface evaluation, it must be assumed that operators have sufficient experience using the TIC User Interface in order to be able to provide comprehensive and reliable feedback. It is assumed that the same TIC staff will operate the TIC throughout the period of the evaluation in order to ensure continuity of data collection. It must be assumed that operators are neither positively nor negatively biased in their attitudes towards the interface. For all TIC User Interface MOEs it must be assumed that the TIC operators and the supervisor are available to take part in the survey process. It will also be assumed that the TIC operator observation log is being completed on a regular basis, whenever a relevant issue requires reporting, and that log entries are accurate and complete.

Regarding the on-site observations to be made by the human factors specialist, it must be assumed that the presence of an observer does not cause operators to alter their working practices or methods of completing tasks in any way.

*Key constraints*

The key constraint, or limitation, of the TIC User Interface evaluation process which must be

taken into consideration is the limited number of operators who are employed with the *ADVANCE* TIC. The data collection will involve the full population of TIC operators, but due to the extent of the targeted deployment and the degree to which the *ADVANCE* TIC operations are automated, the population in fact represents very few subjects.

In addition, due to the proportion of resources allocated to the User Interface evaluation component within the overall TIC evaluation, the level of analysis which can be performed is restricted to a degree. However, this funding level represents the actual significance of the User Interface within the TIC subsystem, as a great number of the processes are fully automated and require little or no interaction with the operator.

*Privacy considerations*

Though the TIC operator observation log requires operators to provide their identity this is only for the use of the DCCO team should any clarifications of comments provided be required. All information received from TIC operators will be entered in the Final Report anonymously, and specific comments will not be attributed.

### 2.2.3.1.4 Key evaluation events

The key evaluation events are itemized in this section. Further detail on the scheduling and interdependencies of the various evaluation activities is provided in the Section 2.1.3.2, the Test Scheme, and Section 3, the Test Management Plan. Evaluation events are described in terms of weeks from commencement of the evaluation period, in order that the plan does not require updating should the evaluation start date be subject to change.

| | |
|---|---|
| **Week 1** | Pre-test activities |
| **Week 5** | Commencement of all data collection and analysis activities |
| | Perform daily data validation checks |
| | Submit first weekly progress report to *ADVANCE* Evaluation Manager |
| **Week 6** | Start weekly data validation checks |
| **Week 11** | Prepare interim evaluation report for Weeks 5-10 |
| **Week 16** | Conclude evaluation data collection activities) |
| **Week 24** | Complete final evaluation reports |

### 2.2.3.1.5 References

*ADVANCE* Evaluation Program Plan. Document #8400.ADV.03. July 17 1995.

2.2.3.2 Test scheme

2.2.3.2.1 Physical description

*Test scenario*

The test scenario for the TIC User Interface evaluation activities is the *ADVANCE* Project Office, mainly the TIC itself during targeted deployment system operation. The data collection activities form two main types: first, the completion of the TIC operator observation log; and second, the survey and evaluator observation processes.

*Work Breakdown Structure for participants*

De Leuw, Cather & Company (DCCO)

- Perform overall evaluation management
- Perform data collection and analysis activities
- Monitor evaluation progress to ensure that task scheduling remains on target
- Ensure Quality Assurance procedures are adhered to
- Prepare all interim and final reports

*ADVANCE* Project Office *(ADVANCE* PO)

- Complete TIC operator observation log
- Assist DCCO staff with other data collection tasks where necessary
- Forward data to the DCCO evaluation team
- Participate in questionnaire

2.2.3.2.2 Pre-test activities

*Participant roles and responsibilities*

Table 5 contains the list of tasks to be completed prior to the initiation of the full data collection and analysis effort, with the individual partner responsibilities identified.

| ACTIVITY | RESPONSIBILITY |
|---|---|
| Perform overall evaluation management | DCCO manager |
| Ensure all parties involved in the evaluation tasks are fully briefed regarding their individual responsibilities | DCCO team |
| Train TIC operators and supervisor in completion of TIC operator observation log | DCCO team |
| Ensure all data collection sheets have been finalized and that adequate supplies are available | DCCO team |
| Verify that TIC User Interface is fully operational and that no fintber modifications will be required throughout data collection period | DCCO team |
| Schedule questionnaire and evaluator observation sessions | DCCO team |
| Monitor evaluation pre-test progress to ensure that scheduling remains on target | DCCO manager |
| Inform all participants of start of data collection phase | DCCO manager |

**Table 5 Pre-test activities and responsibilities**

*Resource requirements*

Effort required to complete the pre-test activities is summarized in Section 3, the Test Management Plan. Access to the TIC operators and supervisor for briefing purposes, and for training in the use of the various logs will also be required.

*Location*

*ADVANCE* Project Office

*Dry runs and training*

Dry runs of the TIC operator observation log and the TIC evaluation questionnaire will be undertaken during the TIC operator training session. The DCCO evaluation manager will also ensure that the evaluation team staff involved in data collection are fully informed of the procedures for data collection and analysis. TIC operators will be advised that data to be collected for the TIC User Interface evaluation will be utilized exclusively to assess the design of the interface, and that individual operator performance is not to be evaluated.

*Data management procedures*

The results from the completion of the TIC operator observation log and the TIC evaluation questionnaire during the training session will be analyzed to ensure that data is being comprehensively collected and entered on the log, and that the types of data collected are sufficient to enable the objectives of the evaluation to be met. Any recommended revisions to the

data collection tools will be approved by the *ADVANCE* Evaluation Manager and IDOT prior to implementation, and will be documented fully in the weekly progress memorandum, and appended to the TIC User Interface test plan.

2.2.3.2.3 Test conduct activities

*Participant roles and responsibilities*

Table 6 contains the list of tasks to be completed during the data collection and analysis effort, with the individual partner responsibilities identified.

| ACTIVITY | RESPONSIBILITY |
|---|---|
| Continue overall evaluation management | DCCO manager |
| Perform data collection and analysis activities | DCCO team |
| Monitor completion of TIC operator observation log | DCCO team |
| Participate in questionnaire and evaluator observation sessions | DCCO team / *ADVANCE* PO |
| Perform data collection using the TIC operator observation log | *ADVANCE* PO |
| Assist DCCO staff with other data collection tasks where necessary | *ADVANCE* PO |
| Forward data to the DCCO evaluation team | *ADVANCE* PO |
| Prepare all weekly progress and interim reports | DCCO team |
| Monitor evaluation progress to ensure that task scheduling remains on target | DCCO manager |
| Ensure Quality Assurance procedures are adhered to | DCCO manager |

**Table 6 Test activities and responsibilities**

*Procedures*

The procedures to be followed throughout the data collection and analysis period of the TIC User Interface are described in the following paragraphs.

During the pre-test phase, the TIC operators will have been instructed in the use of the TIC operator observation log they are required to complete, and a data collection and analysis dry-run using this tool and the questionnaire will have been performed. An entry on the log sheet will be completed on each occasion that an observation relating to the User Interface functionality or usability is perceived, or when any other issue relating to the operator's interaction with the system is raised. This log will be completed throughout the entire evaluation period, Weeks 5-16. At the end of each day during the first week of live data collection, and weekly thereafter,

the log will be reviewed to ensure that data is being logged on a consistent basis and that entries are complete. Should any clarification of log entries be required, this will take place weekly as part of the regular log checking procedures.

Certain parts of the data for all the User Interface evaluation MOEs will be collected by means of the structured questionnaire. The questionnaire will be administered in Week 12 of the data collection and analysis phase when live operation of the TIC has taken place for approximately two months. It is estimated that the questionnaires will take approximately 1 hour to administer to each TIC operator, depending on the amount of input received in response to the open questions. The results from the analysis of the questionnaire will be reviewed in Week 14 of the evaluation phase to allow any additional data to be collected, or clarification on results to be obtained before the end of Week 16, if required.

Additional data is to be collected by means of the evaluator observation sessions. A list of criteria for the evaluator observations will be provided in Week 6. It is anticipated that three sessions of one day each will be required. These sessions will take place in Weeks 8, 12, and 16 in order to be able to monitor any evolution in TIC User Interface usage during the evaluation period. The TIC is operational for approximately 13 hours a day, from 6:00am to 7:00pm. The evaluator observation session will take place during the same timeframe. The precise dates of these sessions will be scheduled in collaboration with the TIC supervisor at least one week in advance. The observer will document any actions or events of relevance to the assessment of the TIC User Interface, It is intended that the observation will be a non-intrusive activity in order that TIC operators will be subject to minimum disturbance of their duties. If the observer requires any clarification of actions undertaken by the operators, clearance from the supervisor to discuss these issues with the operators will be sought.

Following data reduction and analysis, the results of the TIC User Interface evaluation will be reviewed by system designers, the TIC supervisor and the human factors evaluation staff. The product of this process will be a series of recommendations for modifications to the interface if required.

*Location*

*ADVANCE* Project Office

*Data requirements*

The following data will be required during the TIC User Interface evaluation data collection and analysis phase.

- Completed TIC operator observation logs, comprising time and date of observation, and a free text format description of the issue noted

- Input from TIC operators and supervisor on TIC User Interface for questionnaire completion
- Input comprising observations made by the evaluator
- Input from system designers, TIC supervisor, and human factors evaluation staff for formulation of recommendations

*Resources*

Effort required to complete the test activities is summarized in Section 3, the Test Management Plan. In terms of the hardware and software required to assist in the data collection and analysis activities, these comprise the analysis and word-processing packages already available within the *ADVANCE* Project Office. Continuous access to these applications will be required during this stage of the evaluation.

*Data management procedures*

The results from the completion of the TIC operator observation log during the data collection phase will be analyzed to ensure that data is being comprehensively collected and entered, and that the types of data collected are sufficient to enable the objectives of the evaluation to be met. These activities will be reported on in the interim reports. Any recommended revisions to the Evaluation Test Plan will be approved by the *ADVANCE* Evaluation Manager and IDOT prior to implementation, and will be documented fully in the weekly progress report, and appended to the TIC User Interface test plan.

*Procedures for periodic status reports to ADVANCE Evaluation Manager*

The DCCO evaluation team staff will prepare brief weekly status reports and submit these to the DCCO manager for review. These will then also be forwarded to the *ADVANCE* Evaluation Manager and IDOT for approval.An interim report will be prepared during the evaluation phase. It will summarize progress and data collected during Weeks 5-10. Data collected during Weeks 1 l-16 will feed directly into the fmal report together with the data already covered in the interim report.

2.2.3.2.4 Post-test activities

*Participant roles and responsibilities*

Table 7 contains the list of tasks to be performed foIlowing the data collection and analysis effort, with the individual participant responsibilities identified.

| ACTIVITY | RESPONSIBILITY |
|---|---|
| Continue overall evaluation management | DCCO manager |
| Inform all participants of end of data collection phase | DCCO manager |
| Collect all logs and complete data analysis | DCCO team |
| Verify all required data has been collected | DCCO team |
| Ensure Quality Assurance procedures are adhered to | DCCO manager |
| Monitor analysis and reporting progress to ensure that task scheduling remains on target | DCCO manager |
| Prepare final reports | DCCO team |

**Table 7 Post-test activities and responsibilities**

*Resource requirements*

Effort required to complete the test activities is summarized in Section 3, the Test Management Plan. In terms of equipment resources required, full-time access to one PC, and half-time access to a second PC, on both of which the analysis software package and word-processing facilities are installed will be required from Weeks 16 to 24 of the evaluation period. Access to printing and photocopying facilities will also be required.

*Reporting procedures*

*Report format and layout*

The interim and final reports will have the same basic structure to aid cross-checking of interim results with final results. Sections will be omitted from the interim reports for which data has not been collected at the time of their preparation. The document layout will be as described in Section 2.1.3.2.4 of this Evaluation Test Plan. All documentation arising from the TIC User Interface evaluation will be prepared using WordPerfect 6.0a or higher.

*Expected data format / volume*

The quantitative data recorded using logs and then transferred to the analysis software package will have been reduced into various tabular structures to aid the analysis process. The findings from the analysis of this data will be summarized in textual format in the Interim and Final Evaluation Reports. The data tables themselves will be reproduced as Appendices of the Final Evaluation Report. The qualitative data collected by means of the questionnaire and the observation sessions will be presented in a descriptive, textual format.

The volume of data arising from the TIC User Interface evaluation cannot be accurately estimated at the time of writing of this Evaluation Test Plan, but will be estimated following the preparation

of the first Interim Report at the end of Week 8 of the evaluation phase.

***Reporting schedule***

The reporting schedule for the evaluation phase is as follows:

| | |
|---|---|
| **Week 5** | Submit first of the weekly progress reports to *ADVANCE* Evaluation Manager |
| **Week 11** | Prepare interim evaluation report for Weeks 5-10 |
| **Week 16** | Conclude data collection activities) |
| **Week 22** | Submit Draft Evaluation Report to *ADVANCE* Evaluation Manager for review |
| **Week 24** | Complete Final Evaluation Report incorporating feedback |

*Data processing and archival procedures*

All data collected by means of logs, questionnaires, and observations will be archived at the *ADVANCE* Project Office. One camera ready copy and one electronic copy of the Final Evaluation Report will be provided to the *ADVANCE* Evaluation Manager for dissemination.

## 2.3 Quality Assurance scheme

The Quality Assurance (QA) procedures described in this section are largely common to both the TIC Architecture and the TIC User Interface evaluations. These procedures aim to ensure that the integrity and validity of the test data is not compromised. Several aspects of evaluation performance relating to QA have already been outlined briefly in the above sections. The procedures are fully described here for completeness.

### 2.3.1 Validation procedures

During the pre-test activities phase, dry runs of manual log sheet completion and electronic data log compilation will be undertaken during the TIC operator training sessions. Data collection to be validated by this means includes that to be collected for MOEs A. 1.2 TIC hardware reliability, A. 1.3 TIC hardware maintenance requirements, A.2.2 TIC software reliability, A.2.3 TIC software maintenance requirements, A. 1.4 TIC hardware efficiency, A-2.4 TIC software efficiency, and part of the data contributing to MOEs D.2.1 Number and type of difficulties resulting from existing staffing levels experienced during TIC operation which effect TIC efficiency or operator workload, E. 1.2 Number and type of difficulties reported by operators in everyday use, E.2.1 Difference between desired and actual functionality of the TIC User Interface, and E.2.2 Number and type of interface functions not utilized during TIC operation.

The results from the completion of the logs during the training sessions will be analyzed to ensure that data is being comprehensively collected and entered on the logs, and that the types of data collected are sufficient to enable the objectives of the evaluation to be met. Any recommended revisions to the data collection tools will be approved by the *ADVANCE* Evaluation Manager and

IDOT prior to implementation, and will be documented fully in the weekly progress report, and appended to the TIC Architecture or TIC User Interface test plan.

The ongoing validation procedures for the above data types are as follows. At the end of each day during the first week of live datacollection, and weekly thereafter, logs will be reviewed to ensure that data is being logged on a consistent basis, that it is complete. On a weekly basis, the DCCO manager will apply reasonableness checks to all data.

Accuracy of data collected for MOEs C. 1.1 Fixed and variable TIC capital costs, C. 1.2 Fixed and variable TIC operating costs, C-2.1 Number and type of elements of the TIC implementation which could be simplified to reduce cost without compromising system performance, and C.2.2 Alternative cost options will be validated by *ADVANCE* project participants during the review of cost data.

The data to be collected for the remaining MOEs will consist of qualitative data which will be validated by means of either the peer reviews or the discussion sessions with the various participants identified in the earlier data collection methodology sections..

Should any difficulties be identified by the validation procedures, these will be reported on in the weekly status reports. The *ADVANCE* Evaluation Manager will decide the appropriate course of action as required. The procedures for the preparation of periodic status reports are outlined in Section 3, the Test Management Plan.

### 2.3.2 Hardware/software inspection and recalibration procedures

Data on hardware and software status during the test will be derived from the TIC real-time log detailing reliability and maintenance requirements. Should any difficulties relating to test equipment emerge, the IUTRC will provide assistance to return the system to a fully operational state.

### 2.3.3 Provision for maintenance of detailed test event log

A separate test event log will not be maintained by the evaluation team. The weekly status report will fulfil this function as it will cover the progress of current evaluation tasks, and will review the implications for subsequent tasks if scheduling is delayed. The findings of the weekly reasonableness checks on data collected will also be provided in the status reports.

### 2.3.4 Data management and storage provisions

All data resulting from the TIC Architecture operation will be archived weekly, and copies stored at the *ADVANCE* Project Office itself and at Argonne National Laboratory. All data resulting from the TIC User Interface evaluation will be stored at the *ADVANCE* Project Office where both original and back-up copies of data captured will be archived.

## 3. TEST MANAGEMENT PLAN

The detailed test schedules for the TIC Architecture and TIC User Interface evaluations are provided in Figure 1. Figure 2 provides a detailed breakdown of the percentage of effort required, by participant and task.

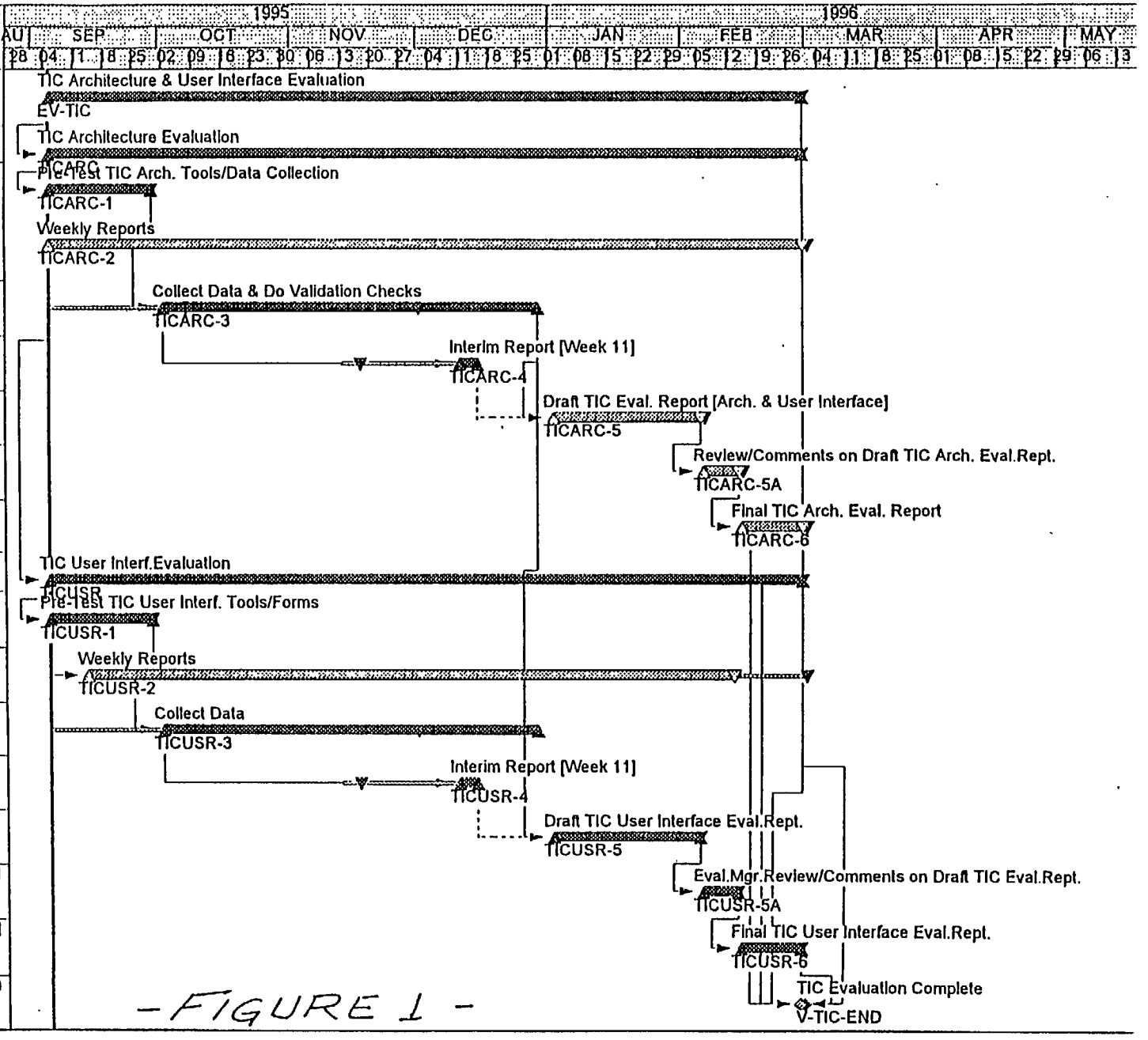
The procedures for the provision of status reports are outlined in the individual test plans. To summarize, brief status reports will be prepared each week by the evaluation staff and submitted to the *ADVANCE* Evaluation Manager for review and approval. These reports will contain details on the progress of current evaluation tasks, and will review the implications for subsequent tasks if scheduling is delayed. The findings of the weekly reasonableness checks on data collected will also be provided in the status reports. In addition, interim reports containing the results of the ongoing analysis of data collected will be prepared in Week 9 and Week 13 by the evaluation staff and submitted to the *ADVANCE* Evaluation Manager and IDOT for review and approval.

Report: Classic Gantt
Layout: Classic Gantt
Filter: All Activities

# SureTrak Project Manager
# ADVANCE TIC Evaluation

DCCO
Report Date: 14AUG95


| Activity ID | Activity Description | Dur-ation |
|---|---|---|
| EV-TIC | TIC Architecture & User Interface Evaluation | 125d |
| TICARC | TIC Architecture Evaluation | 125d |
| TICARC-1 | Pre-Test TIC Arch. Tools/Data Collection | 19d |
| TICARC-2 | Weekly Reports | 125d |
| TICARC-3 | Collect Data & Do Validation Checks | 63d |
| TICARC-4 | Interim Report [Week 11] | 5d |
| TICARC-5 | Draft TIC Eval. Report [Arch. & User Interface] | 25d |
| TICARC-5A | Review/Comments on Draft TIC Arch. Eval.Rept. | 7d |
| TICARC-6 | Final TIC Arch. Eval. Report | 11d |
| TICUSR | TIC User Interf.Evaluation | 125d |
| TICUSR-1 | Pre-Test TIC User Interf. Tools/Forms | 19d |
| TICUSR-2 | Weekly Reports | 106d |
| TICUSR-3 | Collect Data | 63d |
| TICUSR-4 | Interim Report [Week 11] | 5d |
| TICUSR-5 | Draft TIC User Interface Eval.Rept. | 25d |
| TICUSR-5A | Eval.Mgr.Review/Comments on Draft TIC Eval.Rept. | 7d |
| TICUSR-6 | Final TIC User Interface Eval.Rept. | 11d |
| V-TIC-END | TIC Evaluation Complete | 0 |




- FIGURE 1 -